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NOTES ON A POPULATION OUTBREAK OF THE BEETLE *UROPLATA* SP. (COLEOPTERA: CHRYSOMELIDAE) ON THE TREE *BUNCHOSIA PILOSA* (MALPIGHIACEAE) IN COSTA RICA

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Abstract.—An outbreak of the herbivorous beetle *Uroplata* sp. (Chrysomelidae) on the tree *Bunchosia pilosa* H.B.K. (Malpighiaceae) in the central highlands of Costa Rica is described. During the early phase (June) of the rainy season, adult beetles were abundant on leaves of lower branches, where they feed by stripping away tissue from the upper side of leaves. Immature stages of the beetle were not seen, nor was any mating activity observed during the morning hours. Beetles do not feed on the very pilose undersides of the leaves. No other herbivores were seen. As the rainy season advances, the *Uroplata* infestation spreads into the upper portions of the tree, perhaps as a response to increasing adult density and depletion of food supply in the lower region. Infestations were large during June and July (1974) but diminished by August. The phenomenon of population outbreaks in tropical herbivorous insects is discussed.

In the American tropics, the traditional view of insect-plant interactions in relation to community structure has been one of biotically-controlled herbivore populations seldom attaining population outbreak conditions (Pianka 1966). Therefore, population outbreaks of herbivorous insects should be documented and follow-up experimental studies conducted whenever possible.

The purpose of this paper is to call attention to a population outbreak of the beetle *Uroplata* sp.* (Coleoptera: Chrysomelidae) on the tree *Bunchosia pilosa* H.B.K. (Malpighiaceae) in the central highlands of Costa Rica. Owing primarily to the highly specialized and coevolved feeding relationships between herbivorous insects and their host plants in the tropics (Janzen 1973) and the apparent maintenance of rather stable insect populations that fluctuate primarily with seasons in the tropics (e.g., Janzen and Schoener, 1968; Wolda, 1978a, b), the frequency of outbreaks of herbivores associated with any one host plant species is expected to be low. The documentation of such outbreaks in the tropics provides information that can be used for further studies on the regulation, or lack thereof, of insect populations in

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* The taxonomy of Neotropical *Uroplata* is presently too unclear to assign a correct specific name to the species studied in this paper.

the tropics. This paper describes some of the major features of the *Bunchosia-Uroplata* interaction. I use the term "outbreak" in this paper to refer to a large population increase of a phytophagous insect species on a single individual of a tree species. In the traditional sense, outbreak refers to large numbers of insects on many plants in an area. In the tropics, given the very patchy spatial distribution of many tree species, outbreaks may be confined to only certain individuals of a certain species.

Locality and Study Methods

The interaction of *Uroplata* beetles with *Bunchosia* was studied June–August 1974 at "San Rafael de Ojo de Agua" (1,000 m elev.), Alajuela Province, Costa Rica, a region described as "tropical moist forest" (Holdridge, 1967). The study site was a single individual adult *Bunchosia* tree (about 10 m tall) growing along the Rio Segundo. At this locality the river is lined predominantly with *Zygia longifolia* (H.&B.) Britton & Rose (Leguminosae) trees. The single *Bunchosia* was the only one of this species encountered in a 0.25 km river-edge survey (both sides) and no individuals were found in nearby pastures (back to 500 m from either side of the river). On June 26, at least several hundred adults of *Uroplata* were discovered on this tree during a census of emerging adult cicadas (Young, 1979). The flattened, almost rectangular black beetles (10 mm long) were easy to see on the leaves. This locality is highly seasonal in terms of the annual monthly pattern of rainfall; a distinct dry season, with little or no rain, occurs between January and April and therefore the observations on *Uroplata* were made in the early rainy season.

Observations were made on the *Bunchosia-Uroplata* interaction over a three-day period in June. The following types of information were recorded: (1) description of damaged parts of the tree, (2) presence of beetles on other trees within 40 m to either side of the infested *Bunchosia* tree, (3) vertical distribution of the infestation on the tree including an examination for immature stages, (4) intensity of the infestation in shady versus sunlight portions of the tree, (5) density of the beetles in sections of high and low infestation, and (6) percentages of leaves destroyed by the beetles on branches of high and low infestation. In addition, the infestation was examined during July and August. The presence of other feeding insects on the *Bunchosia* tree was also noted.

To measure the intensity and vertical pattern of leaf damage from *Uroplata,* several branches were selected from both lower and upper portions of the tree; lower branches were those below 3 meters from the ground. The number of both healthy and damaged leaves on each of several branches from the two regions was recorded as was the number of feeding beetles per leaf. In areas of high and low infestation, an area 2 meters long by 1.5

Fig. 1. A branch of *Bunchosia pilosa* showing leaves damaged by feeding *Uroplata* beetles. The light areas on the leaves are where the beetles have destroyed leaf tissue.

meters high was used to count the number of beetles present and feeding. As estimate of the vertical distribution of the infestation was made by counting the number of light brown patches from top to bottom of the tree. Owing to the large size of the leaves (120 cm^2) and the conspicuousness of the brown patches against the dark green color of healthy tissue, it was easy to estimate the distribution of attack by counting damaged leaves with the naked eye and binoculars.

Results

Uroplata beetles were found only on the *Bunchosia* tree and not on other trees and herbaceous plants in the area. Only adult beetles were found on the tree and these fed in small groups (5–40 beetles) in neat rows. Adults scraped away tissue from the smooth upper side of a leaf. No beetles were seen feeding from the very pilose undersides. The result of this feeding behavior was that leaves damaged by the beetles had large areas of light brown dead tissue (Fig. 1) as beetles did not chew all the way through the

Table 1. Some summary statistics describing the infestation by *Uroplata* beetles as herbivores of the tree *Bunchosia pilosa*.

(1) Branch position (and leaves) and pattern of leaf destruction for 10 lower and 8 upper branches

	Mean no. leaves per branch ($\bar{x}$ ± S.D.)	Mean no. leaves with >33% destroyed surface ($\bar{x}$ ± S.D.)	Mean % damage ($\bar{x}$)
Lower	48.3 ± 22.7	20.9 ± 10.2	44.7 ± 9.62
Upper	45.9 ± 26.3	8.4 ± 8.1	12.9 ± 11.7

(2) Beetle density and approx. % destruction of leaves in 2 patches of high infestation

	Mean no. beetles per leaf ($\bar{x}$ ± S.D.)	Mean % leaves destroyed, and range
Patch no. 1 (12 leaves)	8.3 ± 11.1	57.5 ± 24.7
Patch no. 2 (12 leaves)	9.3 ± 4.5	50.0 ± 10.0

(3) Beetle density and approx. % destruction of leaves in 2 patches of low infestation

	Mean no. beetles per leaf ($\bar{x}$ ± S.D.)	Mean % leaves destroyed, and range
Patch no. 1 (10 leaves)	0.6 ± 1.5	4.0 ± 4.6
Patch no. 2 (15 leaves)	1.5 ± 2.3	1.3 ± 2.9

leaves. Feeding beetles were found during both morning and afternoon hours. Nocturnal feeding was not determined.

Using 33% of more destroyed leaf surface as an indicator of "intense herbivore damage" in this system, leaves on the lower branches were found to be more damaged than leaves on upper branches (Table 1). Leaves of the lower branches had many large brown spots (Fig. 2). In two different patches of intense feeding, the *Uroplata* density was between 8 and 9 beetles per leaf, and with 50% or more of the leaves destroyed (33% or more damage of leaf surface area) in the two samples (Table 1). In sharp contrast, in two patches of low predation, there was about one beetle per leaf (0–2 beetles) and less than 5% of the leaves were severely damaged (Table 1). The leaves of lower branches were more severely damaged than leaves on upper branches (Table 2). On lower branches in patches of intense predation, the actual range in percentage of surface area destroyed per leaf was 30% to 90% even though beetle abundance per leaf was more variable (Table 3). No other insects were observed feeding on the leaves and no immature stages of *Uroplata* were present. No copulating pairs of beetles were seen.

The greatest numbers of beetles were found on leaves in the shade. When a branch bearing leaves being attacked by the beetles was pulled into the

Fig. 2. The lower branches of this *Bunchosia pilosa* tree had many leaves severely damaged by *Uroplata* beetles during the rainy season.

direct sunlight, beetles crawled away within 2–8 minutes. During the morning hours, the beetles occurred in greatest numbers on the upper sides of leaves, and by 1:00 P.M. on sunny days, most beetles moved to the ventral sides of the leaves. Large aggregations (8–40 beetles) were found resting on the undersides of partially or completely destroyed (brown) leaves in the afternoon.

Although the *Uroplata* infestation was high during June (June 26–28), the infestation was even greater on July 14 and 30 and at this time it had spread to the upper portion of the tree. By August 11 no beetles were present on the tree.

Although, as reported above, the infestation of adult beetles on the tree was very large during the 1974 wet season, no outbreaks were seen on this tree over several other years, namely from 1971–1973 and again in 1975. The study site was visited several times in both wet and dry seasons in these years, and no outbreaks of *Uroplata* were seen. There were no outbreaks in three successive years preceding the outbreak year, or in the year following it. Furthermore, the appearance of outbreak numbers of adult

Table 2. The distribution of the infestation of *Uroplata* beetles (Chrysomelidae) on a mature individual of the tree *Bunchosia pilosa* (Malpighiaceae) in central Costa Rica.

Branch positions	Branch no.	No. leaves per branch	No. leaves 33% destroyed	% Destroyed
"Low"*	1	19	8	42%
	2	36	20	56%
	3	27	14	52%
	4	77	35	45%
	5	83	42	51%
	6	41	15	36%
	7	43	19	44%
	8	64	19	30%
	9	26	15	58%
	10	67	22	33%
"High"	1	94	21	22%
	2	72	15	21%
	3	55	17	31%
	4	41	7	17%
	5	35	4	11%
	6	30	1	0.3%
	7	23	1	0.4%
	8	17	1	0.6%

* "Low" branches are those 3 meters or less above the ground; "high" branches are above 3 meters to top of canopy.

beetles on the tree was seen only in the 1974 wet season, despite the fact that a distinct dry season occurs in the region.

Discussion

From studying herbivorous insects in the Central American tropics over the past 11 years, I attach the term "population outbreak" to the infestation of *Uroplata* beetles on *Bunchosia* since the numbers found were far greater than I have seen for Chrysomelidae on many plant species, and generally for other herbivorous insects in general. For the Chrysomelidae, in herbaceous to slightly woody plants with a canopy of 2 meters or less (in secondary succession), beetle numbers per plant generally ranged from 1–20 (pers. obs.). During the early rainy season in Costa Rica, new flushes of vegetative growth on many plant species promotes the growth of insect populations (Janzen and Schoener, 1968; Janzen, 1973) and herbivorous insects may synchronize emergence and peak adult abundance with periods of high availability of plant tissue utilized as food.

In natural communities, predators and parasites on herbivorous insect species are also expected to have population cycles synchronized with their hosts (Allee et al., 1949). In plant communities where human or catastrophic

Table 3. The distribution of *Uroplata* beetles in two patches* of lower branches of the tree *Bunchosia pilosa* where infestations were high.**

Bunchosia leaf patch	Leaf code no.	No. beetles present	% Leaf area destroyed
1	1	3	90%
	2	39	75%
	3	3	90%
	4	0	30%
	5	9	30%
	6	0	40%
	7	20	75%
	8	2	20%
	9	6	45%
	10	6	45%
	11	9	50%
	12	2	90%
2	1	11	60%
	2	9	50%
	3	3	40%
	4	4	60%
	5	4	50%
	6	12	50%
	7	11	70%
	8	7	40%
	9	8	30%
	10	8	50%
	11	12	50%
	12	9	60%
	13	7	40%
	14	14	50%
	15	21	50%

* Each "patch" has a one-by-one meter area of dense leaves within the lower branch region of the tree.

** The areas of high beetle densities were selected in the lower branch region at the time of census. Censuses in both patches were conducted between 9:50 A.M. and 1:00 P.M. on the same day, with about equal time spent counting beetles and leaf damage in each one.

disturbance has resulted in a reduction of plant species diversity locally, the probability of outbreaks of herbivorous insects is greater than in communities characterized by higher plant diversity (Pimentel, 1961). Climatic explanations of insect outbreaks are generally confined to regions characterized by harsh environmental conditions with large fluctuations annually (Elton 1927). Such effects are generally not expected in the tropics, although the interaction of (1) highly synchronized population cycles in seasonal environments and (2) the long-term reduction in host plant diversity are expected to result in population outbreaks of herbivorous insects in the trop-

ics. Is this what is occurring the the *Bunchosia-Uroplata* system in central Costa Rica in the early rainy season? With more data from several trees, I believe that the answer to this question would be "yes."

Regions of the world with considerable variations in annual rainfall promote large fluctuations in insect abundance (Birch, 1957; Wolda, 1978b). The central highlands of Costa Rica represent seasonal environments in terms of rainfall, and year-to-year variations in rainfall may contribute to fluctuations in insect populations, perhaps in some years pushing some species into the population abundance zone of outbreak conditions. Consistent and comparable annual rainfall data for San Rafael de Ojo de Agua are not available for such a correlation for the *Bunchosia-Uroplata* interaction. Sixty genera and approximately 800 species of woody vines, shrubs and trees comprise the Neotropical Malpighiaceae, and *Bunchosia* is one of the largest genera (Hartshorn 1971). *Bunchosia pilosa,* known in Costa Rica as "Cerezo" or "Orquetilla," occurs most commonly between 110–1,800 meters above sea level and ranging from Costa Rica to Colombia (Standley 1937). Hartshorn (1971) mentions that *B. pilosa* is rare at "Finca La Selva" in the northeastern lowland rain forest (98 m elev.) region of Costa Rica. This tree generally has a patchy spatial distribution in highland forest environments and as such, it is probably a highly dispersed and inconspicuous resource for host-specific herbivores. Furthermore, in the central highlands of Costa Rica, a large percentage of natural forest has been removed as the result of human activity, contributing to the scarcity of this tree at localities such as San Rafael de Ojo de Agua. At this locality, forest trees are presently limited to the margins of rivers and streams, sometimes in steep gulleys. If this particular species of *Uroplata* is host-specific for *Bunchosia,* infestations of this herbivore will also be patchy. In highly disturbed habitats, the interactions between *Buchosia* and *Uroplata* could result in outbreaks of the beetle if reduction in plant species diversity has also resulted in a reduction in the availability of predators and parasites of the beetle (see Pimentel, 1961 for a general discussion).

The data suggest that the *Uroplata* infestation begins and mushrooms in the lower region of the *Bunchosia* tree. The spread of the infestation into upper portions of the tree later could be a density-related response to increased adult densities and decreasing food supply in the lower region during the rapid growth of the adult beetle population.

Although the outbreak numbers of adult beetles occurred during the early phase of the 1974 wet season, a large larval population must have been present prior to this period. The life cycle of *Uroplata* beetles is not known, and as pointed out by Arnett (1963), most of the species in the tribe Uroplatini of the subfamily Hispinae (about 1,500 species world-wide) are tropical and very poorly described and far less understood. Whether or not there is an actively growing larval population in the dry season, or whether the

dry season is passed as a diapausing egg, larva, or pupa, remains to be studied. In some species of phytophagous beetles, adult numbers are regulated by interspecific competition, and sometimes the intensity of such competition is influenced by local climatic factors (Utida, 1961). Populations of a host-specific temperate-zone weevil *Sitona regensteinensis* are regulated by heavy mortality of eggs and larvae from parasites and predators (Danthanarayana, 1969). It is sometimes the case that both density-dependent and density-independent factors regulate populations of phytophagous beetles (Parnell, 1966; Beaver, 1967). Part of the explanation of outbreaks of locusts is related to annual variations in rainfall patterns in target areas (Gunn and Symmons, 1959). A sudden outbreak of *Uroplata* beetles on *Bunchosia* could result from very favorable climatic conditions affecting larval populations. Furthermore, given the highly disturbed condition of the habitat, predators and parasites of *Uroplata* may no longer be present, reducing the operation of density-dependent mortality factors and increasing the role of density-independent factors such as rainfall or lack thereof. In the Chrysomelidae, the larvae often feed on the same host plants as the adults (Huffaker, 1953) and can sometimes become severe defoliators when regulatory factors are absent. Given the high densities of *Uroplata* adults, and although the sample is small, larval survival must have been very high, suggesting an absence of density dependent control or unfavorable climatic conditions in this particular year. As the outbreak was not present in other years, variations in climatic conditions may affect predators and parasites of *Uroplata* on this tree.

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